IDAHO NATIONAL ENGINEERING LABORATORY,
ADVANCED REENTRY VEHICLE FUZING SYSTEM
Scoville Vicinity
Butte County
Idaho

HAER No. ID-~~32~~ 33-B
INEL-97-00066

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Western Region
National Park Service
Department of the Interior
Seattle, Washington 98104

HAER
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HISTORICAL AMERICAN ENGINEERING RECORD

IDAHO NATIONAL ENGINEERING LABORATORY,
ADVANCED REENTRY VEHICLE FUZING SYSTEM HAER No. ID-33-B

Location: Within the Idaho National Engineering Laboratory, approximately 45 miles northwest of Idaho Falls, Idaho, Butte County, the NE 1/4 of Section 22, Township 4 North, Range 30 East, Boise Meridian.

Date of Construction: 1965

Designer/Architect: F.C. Torkelson Company, Salt Lake City, Utah

Builder: Howard S. Wright Construction Company, Seattle, Washington.

Present Owner: United States Department of Energy

Present Use: The site has been demolished, filled, and cleared.

Significance: The ARVFS facility was built for the United States Air Force to evaluate the impact of gamma radiation on certain packages of instruments related to the fuzing system of guided missile warheads.

During the mid-1960s, the American missile program was evolving both offensive and defensive capabilities with respect to guided missiles. The ARVFS bunker and the gamma exposure of a fuzing system were a very small part of a major national priority to maintain weapons superiority over the Soviet Union.

After its initial use, the facility was used for a similar test in 1968 by health physicists at INEL to evaluate the accuracy of computer-generated codes (which predicted gamma radiation exposure in certain situations) against an actual exposure. The test exposed dosimeter film.

Other opportunistic uses of the facility occurred thereafter. In 1980, pellets of fuel rods were tested using various kinds of charges, including a shaped charge, in the water storage tank at the facility. In 1974 four containers of contaminated NaK, previously stored at EBR-I, were moved to the bunker for safekeeping and isolation.

The ARVFS facility, which was of such transient utility that neither electricity nor telephone ever were extended to the site, is a small part of the Cold War and the Arms Race. It represents one of an infinite list of details executed to guarantee a weapon that would do the destructive work for which it had been designed. Subsequent uses demonstrate adaptive re-use of available facilities by scientists and engineers.

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PART ONE

INTRODUCTION TO THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

The Atomic Energy Commission established the National Reactor Testing Station (NRTS) in 1949 as a place where the safe development of nuclear energy for peaceful purposes could take place. The site in eastern Idaho on the deserts of the Snake River Plain was chosen for its abundant supply of subsurface water and its relative isolation from densely populated settlements. The land already was in public ownership because the U.S. Navy had used it as a proving ground in connection with its Pocatello Ordnance Depot during World War II.

The Site, as it is commonly referred to by employees and residents of surrounding communities, presently consists of about 890 square miles. The business of the Site was to experiment with and thereby accumulate and disseminate knowledge about nuclear reactors. The Atomic Energy Commission hired a private contractor to operate the central management functions of the installation, while subcontractors built individual reactor tests and related experiments and projects. By 1965, when the ARVFS story begins, nearly 40 reactors had been built. In 1974, the name of the NRTS was changed to Idaho National Engineering Laboratory, or INEL; in 1997, to Idaho National Engineering and Environmental Laboratory.

As the Cold War and the arms race between the United States and the Soviet Union materialized, the National Reactor Testing Station became home not only to the peaceful applications of atomic energy, but also to military ones. Many larger projects, such as the U.S. Navy's nuclear-powered submarine and the U.S. Air Force's nuclear-powered bomber, were generally known by the public to be under development, even if their details were secret. However, some smaller-scale military efforts were highly classified and had no public visibility at all.[1]

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[1] For a history of the INEL facilities related to the nuclear-powered bomber, see Susan M. Stacy, <u>Idaho National Engineering Laboratory, Test Area North, Hangar 629, HAER No. ID-</u>

PART TWO

DESCRIPTION OF THE ARVFS SITE AND STRUCTURES

At Idaho National Engineering and Environmental Laboratory, several very large centers of activity are distributed over the vast expanses of the area. In the southwestern section of the site is the Central Facilities Area, consisting of numerous warehouses, offices, and other buildings related to the overall management of the laboratory. At the northeast corner of the site is a center called Test Area North, a large complex of buildings built originally in the 1950s for the Air Force's quest to develop nuclear-powered turbojet airplane engines, and the locus of many later tests and programs. Connecting these two sites, about 25 miles distant from one another, is a road named the Lincoln Boulevard, which traverses the desert in a northeasterly direction. To the left and right of the highway are access roads to major complexes such as the Chemical Processing Plant, the Test Reactor Area, and the Naval Reactors Area. The environment surrounding each of these areas is a sagebrush-covered plain, more or less flat, but with some rolling topography. Distant views are of the Lemhi Range to the north and the Lost River Range to the west.

To approach the ARVFS site, one takes the Lincoln Boulevard from the Central Facilities Area and heads north. After passing the last major access road to the Naval Reactors Area, the road crosses the Big Lost River, an intermittent waterway. About 1,500 feet further, a dirt haul-road takes off to the east. Taking this road and traveling about 3,250 feet, the driver comes to at a short access driveway and turns north on it to arrive at the tiny ARVFS site. The site is quite isolated from other activity centers; the view in all directions consists mostly of the sagebrush plain and the distant mountains to the north and west. (See Photo HAER No. ID-33-B-28 for a map with sight-line distances between the Naval Reactors Area and the ARVFS bunker.)

The ARVFS bunker was demolished in 1996. The site of the bunker now reveals nothing more than a scar where vegetation is just beginning to reestablish itself. Therefore, the description

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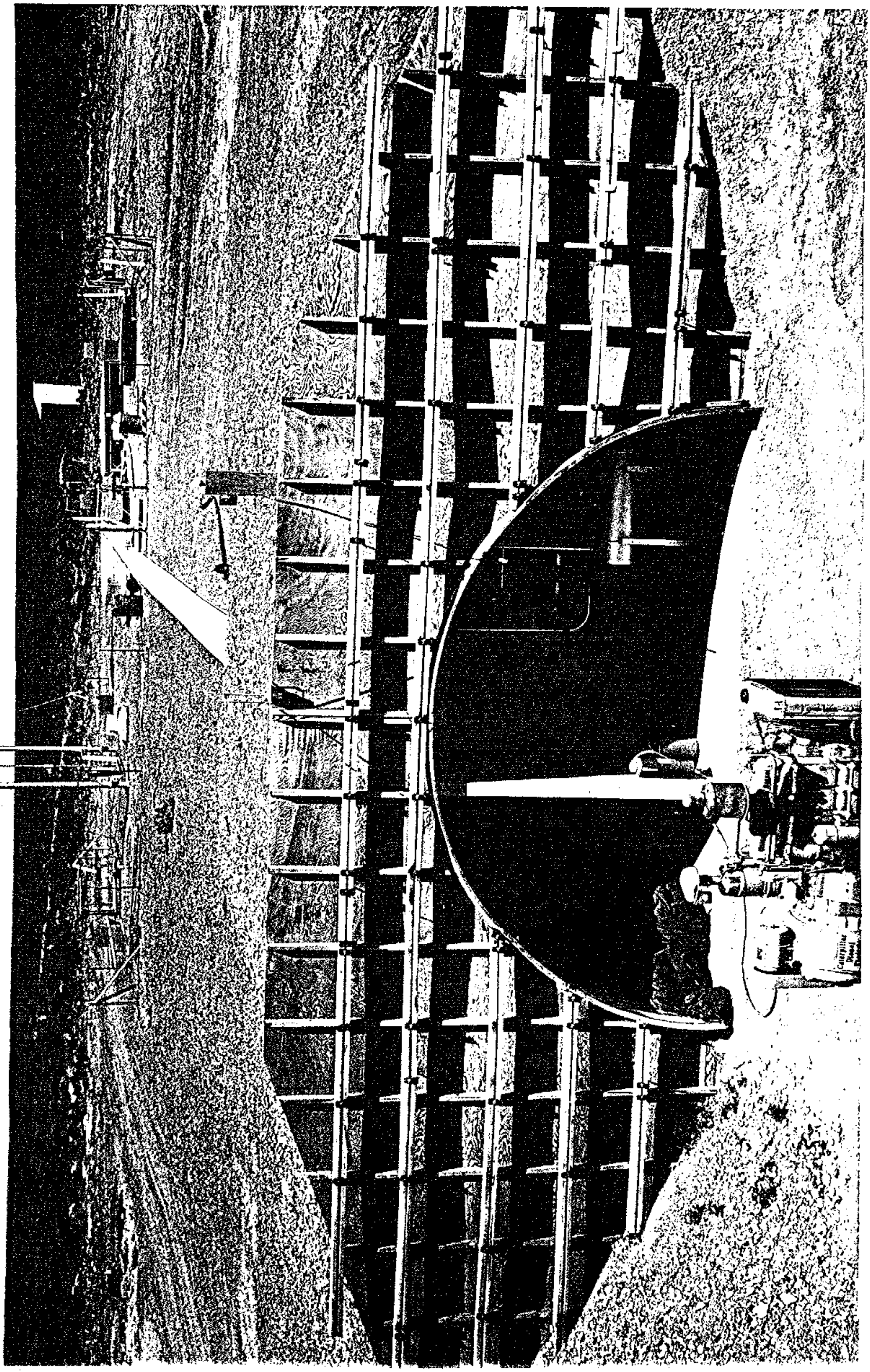
33-A, on file at the Idaho State Historical Preservation Office.



The ARVFS Bunker in 1967   *HAER No. ID-33-B-20, INEL 67-2853* of the facility which follows is based on photographs taken during the conduct of historical activities at the site and on construction engineering drawings. (See the Photo Index.)

The purpose of the ARVFS facility was to expose a "package" of electronic instruments to a cloud of gamma radiation in an open-air environment. It is likely that the Air Force wanted to know how reliable its prior calculations were concerning gamma intensity at various distances from a radiation source.[2]

The radiation was to emanate from a flat plane in a controlled and measurable configuration.[3] Gamma radiation is a wave-energy product of radioactive decay which is extremely hazardous to human life when it penetrates the body. Therefore, the design of any facility in which it is to be used must account for the safety of personnel operating the experiment. Further, it was necessary to shield the atmosphere from the gamma and other radioactive emissions from the radiation source except for the few minutes during which the operators conducted the test.

The facility was elegant in its simplicity. It consisted of four main parts: the control bunker, the cable chase, a shielding tank for the gamma source, and a support framework from which to hang the "package" to be exposed.[4] The control center, referred to as a "bunker" by employees, consisted of a corrugated steel arch building (a Quonset-type structure identified in the drawings as "Armco multiplate arch or equal") affixed to a concrete floor 18 feet by 18 feet. The arch was semi-circular and not lined inside. Prior to erecting the bunker, the builder excavated its site to a depth of six or seven feet, at which elevation the concrete floor was placed. The steel arch was about 8 feet high at the center. Once the building was erected, a cover of three feet of earth buried it, supplying a protective shield for the operators of the experiment. The bunker was oriented in an east-west direction, with the entrance facing west.

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[2] Weaver McCaslin, personal letter to Susan Stacy, January 14, 1997.

[3] J.W. McCaslin, <u>Health and Safety Branch Progress Report</u> (Idaho Falls: Idaho Nuclear Corporation, National Reactor Testing Station, 1968), page 4.

[4] Unless otherwise noted, the description and dimensions which follow are derived from as-built engineering drawings produced by F.C. Torkelson Company. Photographic copies of the drawings are included in the Photo Index of this HAER report. See Appendix D for a list of the drawings.

The entry to the bunker needed protection from the earth fill above it, so the front opening was surrounded by a plywood retaining wall secured by a framework of treated wood 2x4s. The bunker was open to the air for a distance of six feet. This space was intended to shelter a portable electric generator, fire extinguisher, and a hydraulic pump and tank. The wall enclosing the control room had its doorway located in the center. This enclosed space furnished room for the operators, their instrument consoles, air-monitoring equipment, and tanks of nitrogen gas.

The rear wall of the bunker had a rectangular opening of 18 inches wide by 12 inches high. This was the entrance to the cable chase (duct), through which control cables, electric power cords, and other communication lines were extended to the shielding tank and the test package.

The cable chase, which began with the hole in the bunker endwall, continued eastward, gradually rising to the natural level of the ground. It extended about 90 feet from the end of the bunker to the lip of the shielding tank. A trough-like structure, it was made of concrete and had a protective cover fashioned of plywood. It was large enough to house 26 pulley cables and other conduits and wires. On the south side of the cable chase was a square concrete pit situated over a dry well dug to an impervious layer. The pit was 4 feet by 4 feet and 3 1/2 feet deep. A floor drain was in the center. It too had a plywood cover. This pit was for "D.C. power supply." (See Photo HAER No. ID-33-B-37.)

The carbon steel shielding tank, with a capacity of 11,600 gallons, had an inside diameter of 12 feet and was buried into the ground to a depth of 16 feet. When filled, the surface of the water was about four inches above the natural grade.[5] The tank rested on a reinforced concrete footing, shaped as a ring under the edge of the tank, that was 1 1/2 feet thick.[6] The tank had a two-part protective cover also fashioned of plywood. The inside of the tank was painted with at least two coats of light-colored paint. A 4 1/2-foot high barb-wire hazard-control fence enclosed an area immediately around the tank about 50 feet by 64 feet. The engineering drawings specified that a sign reading "Danger Radiation Hazard" be clipped to the top strand of barb wire every 15 feet. (See Photo HAER No. ID-33-B-31.)

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[5] McCaslin, page 4, describes the tank as "carbon" steel.

[6] Mike Crane, INEL photographer, who photographed the demolition of the tank, in a telephone interview by Susan M. Stacy, January 15, 1997.

Above the shielding tank was a two-member support framework made of carbon steel pipes set in concrete. The apparatus included a cross beam and a pole affixed to it which functioned to hold whatever sample was to be exposed to the gamma rays. The crossbeam was 30 feet above the surface of the tank. Guy wires supported the framework. The cross beam was not positioned directly over the center of the tank, but rather was offset from it by two or three feet. This was so that the test package, which dangled from a bracket on the sample-holder, would be located directly over the center of the tank. The framework apparatus included manual hoists, guard posts, braces, and cable for raising and lowering the test sample.

Photographs of the site taken in 1965 and 1968 show the presence of a small shed to the east of the tank. People who used the ARVFS site in 1968 do not recall its function. Perhaps it was an outhouse. The engineering drawings do not account for this wooden structure. (See Photo HAER No. ID-33-B-12.)

With its architecture dictated by exactly two imperatives--to protect people and to enable a very specific arrangement of source radiation and target package--the heart of the test facility was in the engineering of its moving parts. The source of gamma radiation for the test exposures was to come from spent fuel elements borrowed from one of the nuclear reactors at the site, probably the Materials Test Reactor (MTR).[7] Fuel elements that have served their purpose in a reactor continue to be "hot," emitting gamma radiation (and other products) for many weeks after their removal from the reactor core. They are stored in water-filled "canals" at the reactor complex until they "cool" somewhat and can be safely stored elsewhere. The ARVFS facility was designed to accommodate four such fuel elements, relatively fresh from a reactor and still emitting gamma radiation. They would be arranged equidistant from each other--two pairs facing each other--near the edge of the shielding tank. In preparation for their transport to the ARVFS site, the shielding tank would be filled with water brought to the site in a tanker truck. At the tank, each of the four fuel elements would be laid on a special support platform resembling a shelf. The four shelves rested on a square support frame, hydraulically operated by the pulleys and cables. An operator, located in the control bunker, would lower the fuel elements to the bottom of the tank until they were needed for the test, when they would be raised into the open air to expose the test package. At the conclusion of the exposure period, the operator would once more lower the support

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[7] Richard Green, in telephone interview with Susan Stacy on January 8, 1997.

frame to the bottom of the tank, where the water acted as a shield against the penetration of gamma rays to the surface of the tank. The earth surrounding the buried tank also acted as a shield. At the conclusion of the test, the spent fuel elements were placed in transport casks and returned to their home "canal" to continue cooling off.

In the event that the square frame failed to lower the fuel elements into the water for some reason, the operator could use one of two back-up safety mechanisms. The shelves holding the elements were each equipped with a spring-loaded hinge. When the operator in the bunker pulled the appropriate pulley, the spring released the hinge, tipping the shelf and dumping the fuel element into the water. Photo HAER No. ID-33-B-17 shows an operator seated next to the four cable-release mechanisms in the bunker. A second back-up, a pneumatic lowering device, also could be activated from the bunker.[8]

Neither electric power nor telephone were installed at the site. The construction of the bunker probably began after August 11, 1965, the day that "B.H.," an Atomic Energy Commission official, signed off on the engineering drawings. The bunker was 65 percent complete on September 22, and 99 percent complete on October 20. It took about three months to build an environment in which a test lasting a few minutes could take place.[9]

PART THREE

THE USES OF THE ARVFS BUNKER

The United States Air Force Weapons Laboratory

The engineering drawings for the ARVFS field test facility were supplied by F.C. Torkelson Company, a firm headquartered in Salt Lake City with a branch office in Idaho Falls. The contractor/builder was the Howard S. Wright Company of Seattle, Washington. At the time, the general contractor operating the site for the Atomic Energy Commission was Phillips Petroleum.[10]

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[8] McCaslin, page 5.

[9] Most of the drawings are included in the Photo Index which accompanies this report.

[10] According to the NRTS "Thumbnail Sketch" for 1965, the Torkelson Company operated a materials testing laboratory on the Site. Howard S. Wright Company operated an aggregate and concrete

As was customary, contractors photographed the progress of construction. A photograph dated October 20, 1965, shows an Air Force officer examining the shielding tank and its spring-loaded safety mechanisms. (See Photo HAER No. ID-33-B-15.) On his uniform is a patch insignia identifying him as from the Air Force Weapons Laboratory. Another photograph shows the same insignia on the door to the outhouse-like shed. A paper sign tacked to the shed door says, "BSD Liason Office," an acronym not familiar to present employees.[11]

The Air Force Weapons Laboratory was a predecessor agency to today's Air Force Special Weapons Center, located on the premises of Kirtland Air Force Base in New Mexico. The Weapons Laboratory was concerned with, among other weapons issues, the development of the nuclear warheads within the reentry vehicles (nose cones) of guided missiles. The sole purpose of all the expense, engineering, development, and research connected with guided missiles was to successfully detonate the nuclear explosion over the enemy target. Essential to this was the perfect performance of the fuzing system within the warhead.[12]

A fuze is a device in a military projectile which sets off the explosive munition. Several different types of fuzes can be used depending on how the explosive is expected to perform. Above all else, the fuze regulates the functioning of the weapon and causes it to perform only under predetermined conditions. Depending on the weapon and the nature of the target (in air or on land, for example) a fuze may be impact (functions as it hits the target), time (set to function after a certain period of time has elapsed after a starting point), command (functions on signal from a remote control point), proximity (function at a given distance from the target), or inferential (infers that a target is nearby if certain conditions are present.) Some warheads have more than one fuze or type of fuze to assure a backup performance if the primary system fails.

By the mid-1960s, the United States had developed and deployed many guided missile weapons systems, the Thor, Atlas, Minuteman, and Titan among them. So had the Soviet Union. One of the major developmental issues by 1965 was that the defensive

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batch plant on the Site.

[11] See Photos HAER No. ID-33-B-11 and ID-33-B-12. A booklet called <u>INEL Acronyms</u>, prepared by the 1992 era site contractor, EG&G, contains no definition for "BSD."

[12] The spelling "fuze" is traditional for military usages.

capability against missiles was beginning to dilute the offensive potential of missile weapons. General Bernard A. Schriever, Commander of the Air Force Systems Command and the celebrated director of the Ballistic Missile Command which developed the Atlas and other missiles after 1954, said in a 1965 interview, "We have a substantial advanced reentry vehicle program going on right now...We will continue to build more sophisticated re-entry vehicles to confuse any possible defense."[13]

Within this context, the perfect performance of the fuzing systems inside the reentry vehicle under all possible conditions was an important issue. How would the electronic and other parts of a fuzing system function if they were exposed to the effects of nuclear radiation themselves? Would the system hold up and perform? In the mid-1960s, the Air Force assigned many contracts for the purpose of developing "future penetration of target areas in the event of war involving ballistic missiles." It is likely that Advanced Reentry Vehicle Fuzing System test facility at NRTS was one of these many contracts.[14]

The reports that would describe more fully the specific parameters of the questions to be answered by the activities conducted at ARVFS remain classified. Likewise, the results of such tests and experiments are classified.[15] However, after the Air Force use of ARVFS, another group made use of the site to conduct very similar inquiries.

The Health and Safety Branch

The Idaho Nuclear Corporation, the Site contractor in 1966, created a radiological safety analysis team that year to provide it with its own safety analysis capability. Previously, that capability had been contracted. The mission of the three-person team was, among other responsibilities, to establish safe

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[13] Ernest G. Schweibert. A History of the U.S. Air Force Ballistic Missiles (New York: Frederick A. Praeger, 1965), page 24.

[14] Schweibert, page 145. Also, Richard Green, interview by Susan Stacy, January 8, 1997.

[15] The author thanks Dr. Robert Duffner of Phillips Laboratory at Kirtland Air Force Base for confirming the classification of 1965 and 1966 documents pertaining to Advanced Reentry Vehicle Fuzing Systems research, telephone interviews January 8 and 9, 1997.

operating procedures for the protection of personnel handling and working with dangerous radioactive substances at the Site. In addition, the group was responsible for monitoring employees' short and long-term doses of exposure to radiation. The team evaluated the potentials and risks of receiving doses of ionizing radiation under various circumstances and in various meteorological conditions. In the event of accidental releases into the air of ionizing radiation, gas plumes, or other dangerous substances, it was important to know the probable geographical distribution and dispersion characteristics of the materials and their threat to human safety and health.[16]

To assist in risk assessment and analysis, the health physicists in the branch used computer programs to help predict ground level concentrations of emissions coming from continuous releases from fixed points, such as exhaust stacks. With input from wind rose data, such programs produced plots showing the size and direction of an airborne plume. With these aids, safety analysts evaluated alternative evacuation routes in the event of accidents, for example, and many other routine operational problems such as providing adequate shielding.

One of the computer programs was named "Radiological Safety Analysis Computer Program (RSAC), originally written in Machine language (MAP). The analysts in the branch were asked to transcribe this program into FORTRAN IV so that it could be made available to a wider range of users. In the process of doing this transcription, the analysts modified and, they hoped, improved the code.

Following the development of the modified RSAC code, the safety analysis group within the branch decided to compare the computer code predictions with a simulated radioactive material release. They wanted to know if the code would accurately predict the cloud-gamma dose, with its associated "build-up," for a cloud of radioactive material that could be simulated by an array of four irradiated fuel elements.

Someone in the group knew of the existence of the ARVFS facility and suggested that it would be an ideal place to conduct an experiment to test the computer code's prediction.[17] They sought and received approvals from the NRTS contractor, then the

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[16] McCaslin, page 1-2.

[17] Henry Peterson, health physicist and one of the designers of the experiment, in interview by Susan M. Stacy at Idaho Falls, December 11, 1996.

Phillips Petroleum Company, and proceeded. The experiment unfolded much like the original Air Force work must have two years earlier. Instrumentation was set up in the bunker; someone tested the cable and pulley mechanisms; a portable generator supplied electricity; and a tanker truck filled the shielding tank with water. When all was ready, four spent Materials Test Reactor fuel elements--out of the reactor for only 25 days--were once again selected from the MTR canal, loaded into a shipping cask and onto a transport vehicle, delivered to the ARVFS fuel element holders, and lowered to the bottom of the tank.

Instead of hanging the contents of a nuclear warhead fuzing system from the support frame, the analysts used a helium-filled weather balloon six feet in diameter to support a string of dosimeter packets above the center of the tank. This method of suspending the film provided an unobstructed radiation field between the film badges and the source of radiation. Each dosimeter packet consisted of an acrylic plastic card to which two film badges were attached. On the string suspended by the balloon, dosimeter packets were spaced every 25 feet. The first packet hung 15 feet from the surface of the tank water; the last and highest, 315 feet above the water. The operators affixed the film so that it faced downward at all times during the exposure, which lasted ten minutes.[18]

An additional series of exposures was made using only one fuel element. The targets included other dosimetry systems such as thermoluminescent lithium floride (TLD) discs, ferrous sulfate, TLD encapsulated powder, pocket ion chambers, radiophotoluminescent phosphate glass, and condenser R meters.[19]

After the tests, the analysts compared their hand/computer calculations with the values obtained from the tests. They were gratified. "The agreement between the calculated doses based on RSAC parameters and the corresponding measured doses for both tests was remarkable," wrote the author of a report describing the procedures.[20] The analysts would like to have repeated the experiment using spent fuel elements with a fresher and hotter supply of high-energy, gamma-emitting nuclides, but those plans did not materialize. The cables, pulleys, and other equipment

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[18] McCaslin, page 6.

[19] McCaslin, page 6.

[20] McCaslin, page 8.

were removed and the shielding tank decontaminated.[21]

The EBR-I NaK

NaK is a sodium potassium eutectic alloy, a metal that is liquid at room temperature. It was used as a coolant in one of the earliest experiments at NRTS, the Experimental Breeder Reactor I (EBR-I). In this landmark reactor, this coolant permitted a level of neutron energy so high that the enriched uranium (U-235) fuel was able to "breed" additional fuel in a blanket of natural uranium (U-238) surrounding the core. Under normal operating conditions, the coolant circulated in closed pipes as part of a heat exchange system to carry away heat built up by the reaction in the core.[22]

After EBR-I had proved the principle of breeding, scientists designed other tests at EBR-I to learn more about reactor behavior under anomalous conditions. They wanted to know more about how an increase in the temperature of the fuel would affect changes in reactivity. One of the last of these tests involved the deliberate restriction of coolant flow and a subsequent rise in temperature of the fuel.

On November 29, 1955, during the last of these tests, operators controlling the power levels permitted a power surge that overshot the level at which the fuel melted, producing a partial melting of some of the fuel. One consequence was that the (static) NaK in the reactor vessel was exposed to and contaminated by products of extreme reactivity. People evaluating the incident and its clean-up thought there was a remote possibility that 10.5 grams of plutonium may also have contaminated the NaK. Because plutonium has a long half-life and

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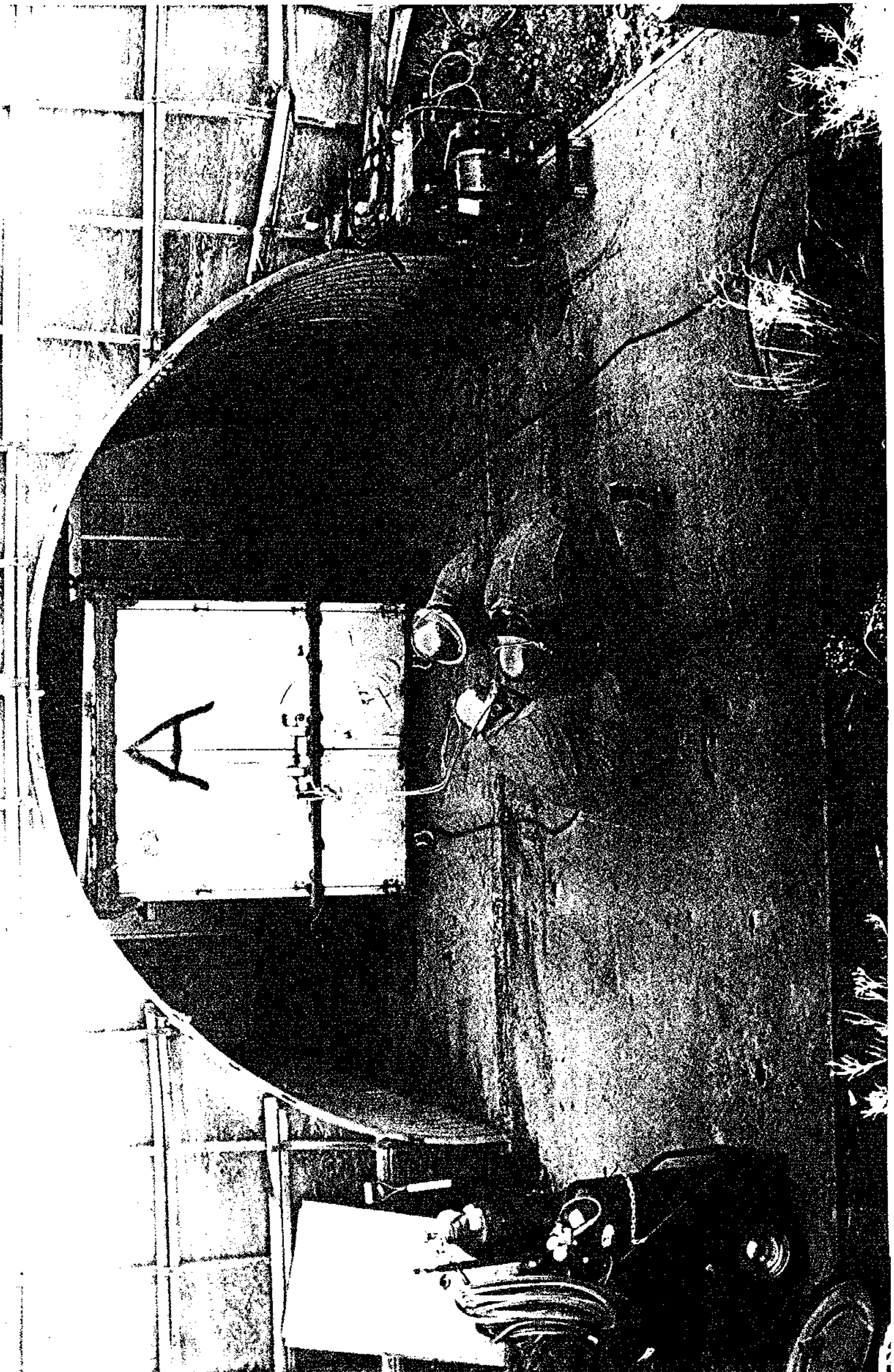
[21] D.L. Smith, Internal Technical Report, Radiological Characterization and Decision Analysis for the Decommissioning of ARVFS (Idaho Falls: EG&G Waste Management Programs Division, 1984), page 3.

[22] Brief descriptions of each of the reactors at the Site were described in "Thumbnail Sketches" prepared by the NRTS, later INEL, annually. This summary came from the 1973 version, page 19. The EBR-1 reactor went critical in 1951. In 1966, President Lyndon B. Johnson designated EBR-1 as a national historic landmark. Since its decontamination, it has been reopened as a museum open to the public.



NaK Dumpster in ARVFS Bunker   *HAER No. ID-33-B-22, INEL 79-7187* is extremely hazardous--and because of the characteristics of the NaK itself--the NaK had to be carefully managed and isolated.[23]

During the clean-up after the partial meltdown, EBR-I personnel put the contaminated Nak in four storage drums and placed them in a storage pit near EBR-I. In 1974 the EBR-I facility, which had been decommissioned in 1964 for lack of further assignments, was slated for decommissioning and decontamination. The NaK had to be moved. Eventually, it would have to be cleaned up or "processed," but in the meantime, it needed another secure storage spot. NaK reacts violently to air and moisture, producing hydrogen, oxides, peroxides, superoxides, and hydroxides that burn living tissue and are otherwise corrosive and irritating to the skin, eyes, and mucous membranes. Therefore, great care was required in handling the containers.

Richard Green, an employee who had heard his boss tell stories about the ARVFS bunker and its early fuze-testing experiments, suggested that the bunker might be a likely place to store the NaK. It had sat unused and empty since 1967. Little was known of its original purpose except that it had been built by the Department of Defense "for experiments of a classified nature." Available reports only noted that the experiments were "secret."[24] A crew loaded the four drums into a steel dumpster, packed it with sand, and hauled it to the ARVFS bunker.

The door to the bunker and its front wall were removed. With the help of cranes, the crew set the dumpster onto the middle of the bunker's concrete floor. They sealed the front opening with a 1/4-inch steel plate, which they welded to the edge of the arch. Then they left.

In August of 1979 the NaK containers were inspected. Workers unsealed the bunker, removed the dumpster, opened it, removed the

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[23] See "EBR-I Core: After the Meltdown," Nucleonics, January 1957, page 84; and Walter Zinn, "A Letter on EBR-I Fuel Meltdown," Nucleonics, June 1956, page 35.

[24] E.V. Mobley, Informal Report, Preliminary Safety Analysis Report for the Decontamination and Decommissioning of the ARVFS NaK, Report No. EGG-WM-7802 (Idaho Falls: EG&G, 1987), page 3. See also D.L. Smith, Internal Technical Report, Radiological Characterization and Decision Analysis for the Decommissioning of ARVFS (Idaho Falls: EG&G Waste Management Programs Division, 1984), page 3. The author interviewed Richard Green by telephone on January 8, 1997.

Welding Door onto ARVFS Bunker *HAER No. ID-33-B-23, INEL 79-7150* sand pack around the four containers, and examined them for rust and other signs of declining integrity. They returned the containers to the dumpster, repacked it with fresh vermiculite and placed it back into the bunker, again welding it shut.[25]

While the NaK waited, waste management experts devised and then discarded various proposals for treating and permanently disposing of the substance. One would have processed it at the ARVFS site itself; another, at Test Area North. Retrospective calculations eliminated the likelihood (through gammaspectroscopy testing) that the NaK contained plutonium. By the time the dumpster was transported to the Argonne West facility at INEL in September 1995 for processing, the ARVFS site was classified as an "interim status waste management unit" under the regulations of RCRA legislation and managed accordingly.[26]

Having lost its mission as a safe pocket for storing the EBR-I NaK, the bunker became a candidate for demolition.

<u>The Waste Forms Response Project</u>

Another mission performed at the ARVFS site involved the shielding tank. The mission involved the use of explosives and produced classified data. It was therefore tightly controlled. EG&G, then the Site contractor, conducted the project in cooperation with the Transportation Technology Center (TCC) at Sandia National Laboratory in New Mexico.

The TCC was concerned with domestic saboteurs or terrorists and what damage they might inflict on the casks used to transport radioactive spent fuel wastes across the country. They wanted to know the types of radioactive aerosols that might be produced in such a situation. If various kinds of charges from certain

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[25] The inspection was photographically documented. Photographer's notes were placed on the negative storage sleeves, which are in the INEL Photographic archive. See Photos HAER No. ID-33-B-21 through ID-33-B-22. See also D.H. Schooner, <u>Internal Technical Report, Decision Analysis for NaK Stored in ARVFS Bunker</u> (Idaho Falls: EG&G Idaho, Inc., 1984) for photos.

[26] See C.E. Klassy and D.E. Keller, <u>Auditable Safety Analysis for the Storage and Handling of the EBR 1 NaK</u> (Idaho Falls: EG&G, 1994), page 4-1; and Jason Associates Corporation, <u>Supporting Documentation for RCRA Closure Certification of the ARVFS Storage (NaK) Unit, FINAL</u> (Idaho Falls: LMITCO, 1996), page 2. Also, Tom Thiel, in interview by Susan M. Stacy at Idaho Falls, December 11, 1996.

weapons were to penetrate a transport cask containing spent fuel, radioactive particles would enter the environment and pose a hazard to the population in the vicinity. Should such an event occur, military and other local authorities would need to know how to operate safely themselves and how to direct the evacuation of the population thus placed in harm's way. They would need to know how far the danger would extend and for how long.

The TCC analysts were preparing operating procedures, or "codes," for such an eventuality. But first they needed to know what amount of dangerous material would actually be released in such an attack. They desired to penetrate a cask with such a weapon and calculate the loss fraction of the contents and the distribution of various-sized radioactive particles. At Sandia, analysts used surrogates for radioactive fuel, but at the ARVFS bunker, they could use actual spent fuel elements.

Richard Green, an explosives engineering specialist, was a member of the test design team. The team transformed the ARVFS tank into an explosives chamber. They built a 9 feet by 17 feet shed 8 feet high of corrugated metal over a wood frame and placed it over the tank. The sheet metal enclosed the roof and three sides. The open side was draped with a fabric named Herculon. They installed a hand-operated crane on the east side of the tank so that equipment could be lowered into and out of it.

The tests involved firing certain types of explosive charges into fuel rod pellets located inside the tank. An aerosol recovery system collected and stored the radionuclides released. The radionuclides and the fuel rod pellets were transported to a hot cell (a special remotely operated chamber designed for the analysis of radioactive materials) at the Test Reactor Area. The test results and associated data are classified, according to Richard Green. He did state, however, that in conducting the tests, some radionuclides were released from the exterior containment system and contaminated the tank.[27]

The shielding tank was decontaminated and removed from the ARVFS site in September 1989. The tank still had light fixtures, a desk, and a ladder inside from the Waste Forms tests. A front-

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[27] Two valuable sources on the WFRP were D.L. Smith's Radiological Characterization report, cited earlier, and Richard Green, interviewed by Susan M. Stacy by telephone on January 8, 1997.

end loader excavated the earth around the tank, a crane lifted the tank, and a truck hauled it to one of the site landfills.[28]

PART FOUR

THE DEMOLITION OF THE ARVFS BUNKER

Public confidence in the beneficial potential of nuclear energy began to erode with the rise of the environmental movement, nuclear accidents at Three Mile Island and Chernobyl, and concerns about the management of nuclear waste products. The end of the Cold War has reduced the urgency for nuclear weapons development. The nuclear research mission of the Idaho National Engineering and Environmental Laboratory began to diminish throughout the 1970s and 1980s.

Congress passed the Resource Conservation and Recovery Act (RCRA) in 1996. This ("Superfund") legislation mandated the cleanup of hazardous wastes, including nuclear waste. Subsequent regulations implemented "cradle to grave" controls for handling hazardous wastes. With the election of Bill Clinton in 1992, Hazel O'Leary became Secretary of Energy. One of her missions was to reduce the size and cost of the physical plant that had accumulated at the country's nuclear laboratories. At INEEL this meant, first, the systematic cleanup of contaminated sites and facilities, and second, the demolition of all facilities deemed to be surplus and not candidates for re-use.[29]

In 1996 this process arrived at the ARVFS site. The steel arch bunker, its concrete floor, and the ruins of the cable chase were hauled away to a landfill at the Site's Central Facilities Area.[30]

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[28] Mike Crane, telephone interview by Susan M. Stacy, January 15, 1997. Crane was the photographer who documented the removal of the tank.

[29] See Department of Energy Order No. 528.2a, Chapter 5, <u>Decommissioning of Radiologically Contaminated Facilities</u> and subsequent revisions.

[30] Tom N. Thiel, project manager for the demolition of the ARVFS site, in an interview with Susan M. Stacy in Idaho Falls, December 11, 1996.

PART FIVE

THE SIGNIFICANCE OF THE ARVFS TEST FACILITY

ARVFS was a small facility that played a series of small roles in much larger projects. It originated as a minuscule fraction of the nation's campaign to achieve and maintain nuclear weapons and missile superiority over the Soviet Union. Thousands of such small fractions must be scattered all over the nation, created to execute highly specific procedures or tests carried out in the name of national security and defense. In and of itself, the ARVFS site was neither original nor unique in concept. Other high-flux gamma irradiation facilities existed on the site, such as the one at the Materials Testing Reactor/ Engineering Test Reactor exclusion area elsewhere on the Site. At Oak Ridge, for example, a large support frame of similar design was erected in the 1950s to expose materials to gamma radiation in the open air.[31]

Thereafter, those who used the ARVFS site for tests or experiments did so opportunistically. It was there. Someone remembered it was there. It would serve. It was recruited. As it was re-used, it was altered to suit. The original opening to the bunker gave way to a welded sheet of metal. The support framework gave way to a weather balloon. The shielding tank cover gave way to a three-sided shed. The ARVFS bunker is typical of adaptive re-use at INEEL, typical of a research-park culture in which engineers and scientists often exercised the art of "scrounging."

Adaptive re-use gave the ARVFS bunker a place in the history of several other larger themes: nuclear health, isolation and disposition of contaminated wastes, and the country's response to terrorism. Its demolition likewise gives it a role in the large theme that we might refer to as the "contraction" of the nuclear research establishment in the United States in the late 20th century. None of the events at ARVFS represented unique or monumental scientific or engineering breakthroughs. They were small-step increments in deliberate exploration on the frontiers of knowledge.

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[31] "Thumbnail Sketch," 1965, page 18. See also Martha Carver and Margaret Slater, Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee (Oak Ridge: Martin Marietta, 1994).

Appendix A

Plot Plan and Photo Key Map for ARVFS Test Facility

This plot plan and key indicates only the three photos that were taken using large-format film. Other photos listed in the Photo Index include a directional description.

Appendix B

Vicinity Map for ARVFS

Appendix C

Complete List of Construction Drawings for ARVFS Bunker. Those marked with an asterisk are included in HAER Report ID-33-B. Directional indications for all photographs are noted in Photo Index.

Sheet 1	842-ARVFS-101-1	Vicinity Map and Drawing Index
Sheet 2*	842-ARVFS-101-2	Location Plan
Sheet 3*	842-ARVFS-701-1	Plan
Sheet 4*	842-ARVFS-701-2	Elevation
Sheet 5*	842-ARVFS-701-3	Sections and Details
Sheet 6*	842-ARVFS-701-S-1	Shielding Tank Assembly
Sheet 7*	842-ARVFS-701-S-2	Shielding Tank Plan and Section
Sheet 8*	842-ARVFS-701-S-3	Shielding Tank Details
Sheet 9*	842-ARVFS-701-S-4	Shielding Tank Details
Sheet 10*	842-ARVFS-701-S-5	Frame Assembly and Details
Sheet 11*	842-ARVFS-701-P-1	Piping Isometric
Sheet 12*	842-ARVFS-701-E-1	Electrical Plan and Section
Sheet 13	842-ARVFS-701-S-7	Cylinder leveling Assembly
Sheet 14*	842-ARVFS-701-S-8	Cylinder leveling Details

BIBLIOGRAPHY

Books and Reports

Baar, James, and William E. Howard. Combat Missileman. New York: Harcourt, Brace & World, Inc., 1961.

Brown, B.W., et al. Functional and Operational Design Requirements for Decontamination and Decommissioning of the EBR-I Mark II NaK: Final Report. Id. Falls: EG&G, 1987.

Burgess, Eric. Guided Weapons. New York: Macmillan Company, 1957.

Bureau of Naval Personnel. Principles of Guided Missiles and Nuclear Weapons. U.S. Navy, NAVPERS 10784-A, Revised 1966.

Burgess, Eric. Long Range Ballistic Missiles. New York: Macmillan Company, 1961.

Hampson, Fen. Unguided Missiles, How America Buys its Weapons. New York: W.W. Norton Co., 1989.

Hartt, Julian. The Mighty Thor, Missile in Readiness. New York: Duell, Sloan and Pearce, 1961.

Howard, William E., and James Baar. Spacecraft and Missiles of the World, 1966. New York: Harcourt, Brace, and World, 1966.

Jason Association Corporation. Supporting Documentation for RCRA Closure Certification of the ARVFS Storage (NaK) Unit, FINAL. Idaho Falls: LMITCo, 1996.

Klassy, C.E., and D.E. Keller. Auditable Safety Analysis for the Storage and Handling of the EBR-I NaK. Idaho Falls: EG&G, 1994.

LaRue, D.M., and M.R. Dolenc. Informal Report: Decontamination and Decommissioning Plan for Processing Contaminated NaK at the INEL. Idaho Falls: EG&G, 1986.

McCaslin, J.W. Health and Safety Branch Progress Report [for 1967 (Report No. IN-1205). Idaho Falls: Idaho Nuclear Corporation, 1968.

Mobley, E.V.Informal Report: Preliminary Safety Analysis Report for the Decontamination and Decommissioning of the ARVFS (Army [sic] Reentry Vehicle Facility Site) NaK. Idaho Falls: EG&G, 1987.

Mobley, E.V., and D.E. Keller. Final Safety Analysis Report for the Decontamination and Decommissioning of the ARVFS NaK. Idaho Falls: EG&G, 1991.

Nucleonics. "EBR-I Core: After the Meltdown." January, 1957, page 84, (no author).

Parson, Jr., Nels A. Missiles and the Revolution in Warfare. Cambridge, Mass.: Harvard University Press, 1962.

Schooner, D.H. Internal Technical Report: Decision Analysis for NaK Stored in ARVFS Bunker. Idaho Falls: Waste Management Programs, EG&G, 1984.

Schweibert, Ernest G. A History of the U.S. Air Force Ballistic Missiles. New York: Frederick A. Praeger, 1965.

Smith, D.L. Internal Technical Report: Radiological Characterization and Decision Analysis for the Decommissioning of ARVFS. Idaho Falls: Waste Management Division of EG&G, 1984.

Thiel, Thomas N. Demolition Plan for Army Reentry Vehicle Facility Station Bunker B17-702. Idaho Falls: LMITCo, 1994.

United States. Department of Energy, Office of Environmental Management. Closing the Circle on the Splitting of the Atom. Washington, D.C.: Department of Energy, 1995.

United States. U.S. Atomic Energy Commission. National Reactor Testing Station Thumbnail Sketch. Idaho Falls: Atomic Energy Commission, 1965.

Von Braun, Werner, and Frederick I. Ordway, III. History of Rocketry and Space Travel. New York: Thomas Y. Crowell Co., 1966.

Zinn, Walter. "A Letter on EBR-I Fuel Meltdown." Nucleonics, June 1956, page 35, 119, and ff.

Interviews

Michael Crane	John Horan
Robert Duffner	J.W. McCaslin
William Gammill	Henry Peterson
Richard Green	Thomas Thiel